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GB A 2153850
GB A 2050207
GB 1530519
GB 1117816
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(58) Field of search
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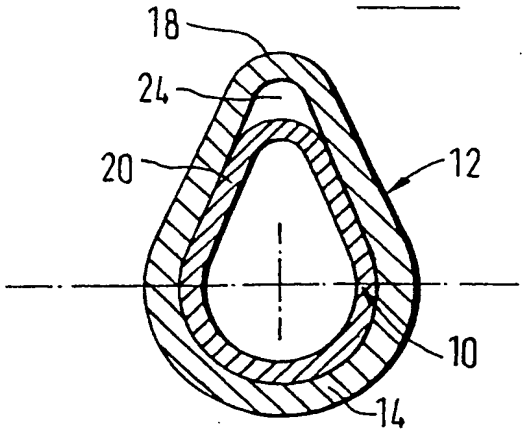
B3J
B3Q
Selected US specifications from IPC sub-class B21D

(54) Securing elements on tubular members

(57) A tubular fabrication e.g. a camshaft for an internal combustion engine, comprises a plurality of cam profile rings 12 secured on a central hollow tube 10. The rings 12 may be cut from a cold drawn section or from an extrusion of the required final cam profile and are held on the tube 10 within a die assembly whilst the tube is radially deformed by the application of internal fluid pressure to cause deformation 20 of the tube within each ring 12 thereby to secure each ring to the tube against movement relative thereto.

FIG. 3.



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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

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FIG. 1.

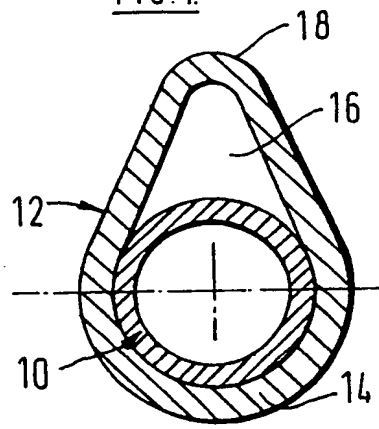
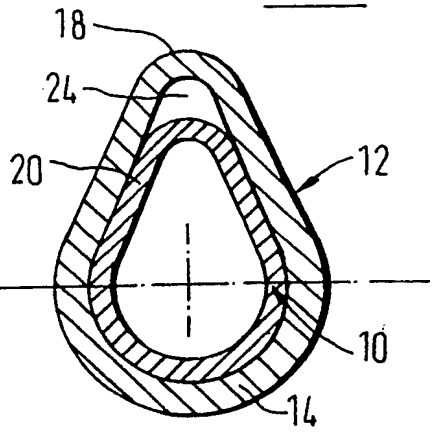


FIG. 3.



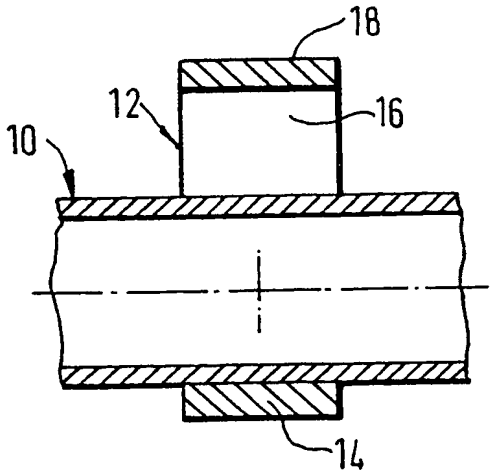


FIG. 2.

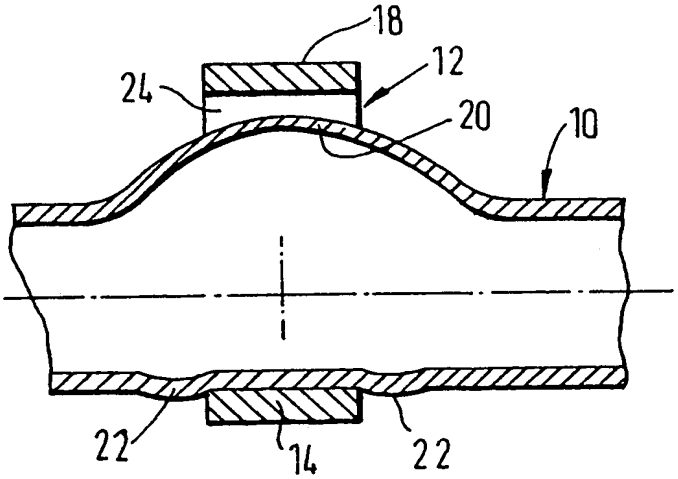


FIG. 4.

SPECIFICATION

Tubular fabrication and method for its production

This invention relates to a tubular fabrication wherein one or more elements are secured to a central tubular member passing through the or each element; such a fabrication conveniently being suitable for use as an automotive component.

Particularly, but not exclusively, the invention relates to a tubular fabrication comprising one or more elements, such as cams, bearings or gears secured to and axially spaced along a central tubular member to provide a camshaft useable for example in a reciprocating piston machine such as a compressor or an internal combustion engine.

Camshafts have conventionally been produced as either castings or forgings, usually of steel, or machined from solid stock and comprising a solid elongate shaft having a plurality of axially spaced apart integral cam form and other profiles thereon.

There have also been proposals to produce a fabricated camshaft wherein a plurality of separate cams and other elements have been mounted on a central shaft, which may hollow, for example by adhesives or by sintering.

It has also been proposed in French patent specification 2 501 321 to expand a hollow tube radially outwardly in a shaped die by internally applied pressure thereby to form integral cam profiles on the exterior of the tube.

It will be appreciated that the proposals described in the two preceding paragraphs have been directed to the production of a camshaft which can be of lighter weight than the conventional cast or forged camshafts.

It is an object of the present invention to provide a tubular fabrication and method for its production, which will offer advantages of weight reduction, cost effectiveness and versatility.

In accordance with the broadest aspect of the invention there is provided a tubular fabrication comprising a central tubular member and one or more elements thereon wherein the tubular member is radially deformed with respect to the or each element to secure it in position against movement relative to the tubular member; said deformation being provided by the application of internal fluid pressure within the tubular member.

Also in accordance with the invention there is provided a method of producing a tubular fabrication comprising locating one or more elements around a central tubular member and radially deforming said member with respect to the or each element by the application of internal fluid pressure within the tubular member to secure the or each element against movement relative to the tubular member.

Such a fabrication provided as an automotive component may comprise a camshaft wherein the said elements comprise one or more cams or bearings or gears. Such elements may be formed as ceramic or sintered elements or may be formed from cut drawn tube or cut from an extrusion.

In one embodiment of the invention such elements comprise one or more cam rings and the fabrication comprises a camshaft having a central tubular member and a plurality of cam profile rings thereon wherein the tubular member is radially deformed with respect to the rings to secure them in position against movement relative to the tubular member; said deformation being provided by the application of internal fluid pressure within the tubular member.

The method of producing such a camshaft comprises locating a plurality of cam rings around a central tubular member and radially deforming said member with respect to said rings by the application of internal fluid pressure within the tubular member to secure the rings against movement relative to the tubular member.

The cam rings may be shaped to at least partial final cam profile before they are secured on the central tubular member although the cam rings may be initially circular and thereafter deformed to the desired cam profile during the fluid pressure application stage when they are located on the tubular member.

In a preferred embodiment of the invention the cam rings are shaped substantially to their final cam profile before they are located on and secured to the tubular member.

The cam rings may be produced from a drawn tube or an extrusion to either a circular, partial cam profile or final cam profile as the case may be. Alternatively the cam rings may be fabricated from strip material and closed, such as by welding, to the desired profile.

The tubular member may be formed of a low carbon steel or aluminium or any other suitable plastically deformable material and the cam rings may be formed of a high strength hardenable ductile steel, or of iron, or of any other suitable material.

The internal fluid pressure may comprise a hydraulic medium although other media may be utilised such as for example a petrol-air explosive mixture within the tubular member.

Other features of the invention will become apparent from the following description given herein solely by way of example with reference to the accompanying drawings wherein

Figure 1 is a transverse cross-sectional view of a cam ring located around a hollow circular tube prior to deformation of the tube

Figure 2 is a side cross-sectional view of the assembly of cam ring and tube of Figure 1

Figure 3 is a transverse cross-sectional view of the cam ring secured to the hollow tube after the application of internal fluid pressure thereto and

Figure 4 is a side cross-sectional view of the secured cam ring and tube of Figure 3.

Referring to Figures 1 and 2 of the drawings, there is shown a hollow tubular member 10 of uniform circular cross-sectional form which is conveniently formed of a low carbon steel and which comprises the central member of the cam shaft. One cam profile ring 12 is shown which is conveniently produced from a cold drawn section of high strength hardenable ductible steel and then cut transversely of the section to form a plurality of such cam profile rings.

It will be noted that the internal radius of curvature of the lower half 14 of the cam ring 12 is substantially identical with the radius of curvature of the outer surface of the tubular member 10; a space 16 being defined between the opposed outer surface of the tubular member and the interior surface of the actual cam lobe 18 of the ring 12.

A plurality of such rings 12 are assembled on the tubular member 10 within a die and internal fluid pressure is then applied to the interior of the tubular member to deform it radially outwardly to the configuration shown in Figures 3 and 4. This deformation, as shown at 20, ensures that each ring 12 is captured to and secured on the tube 10 against all movement relative thereto. In particular, referring to Figure 4, it will be noted that the tube 10 has been deformed radially outwardly around its lower half to provide radially outwardly extending bulges 22 on either side of the cam ring 12 thereby locking the ring against axial movement relative to the tube. It is not necessary that the tubular member is deformed to fully fill the interior of the cam ring 12 below the cam lobe 18 as will be seen from Figures 3 and 4 wherein a space 24 remains between the tube deformation 20 and the interior surface of the lobe 18. However, if desired, the tube deformation may be provided to fill the interior of the cam ring.

Various modifications may be made to the invention without departing from the essential concept thereof. For example, when the invention comprises the camshaft and its method of production as described above, the cam rings may be formed from strip material and welded to the desired profile and such desired profile, whether produced from welded strip or from a cold drawn section, may either be the final cam profile as described with respect to the drawings or may be circular or may be a partial final cam profile.

Furthermore, the cams need not be provided from a drawn section or from welded strip. The cams may be formed by cutting from an extrusion or they may be provided as ceramic or sintered cams. The tube may be formed of aluminium or of any other suitable plastically deformable material. Also, the camshaft may have secured thereon by the method of the invention other elements such as bearings or gears.

When the cam rings are circular, they are provided to a larger internal diameter than the external diameter of the tube whereby, during the application of internal fluid pressure within the tube, both the tube and the cam rings themselves are deformed to the required final shape as determined by the die profile in which the rings and tube are located. Similarly, if the cam rings are provided to partial final cam profile, the tube and rings themselves are again deformed during the application of internal fluid pressure to the desired final profile.

It will be appreciated that the invention is not limited to the production of a camshaft. Any tubular fabrication may be provided in accordance with the invention although it is envisaged that the invention is particularly applicable to automotive components wherein the elements on the tubular member may be provided to any desired exterior profile and formed of any suitable material.

It is preferred that the fluid pressure is applied as a hydraulic medium by a suitable piston connected to one end of the tube, the other end of the tube being sealed, and the whole assembly being located within a suitably profiled die assembly. Alternatively, the internal fluid pressure may be provided by an explosive medium such as a petrol-air mixture.

CLAIMS

1. A tubular fabrication comprising a central tubular member and one or more elements thereon wherein the tubular member is radially deformed with respect to the or each element to secure it in position against movement relative to the tubular member; said deformation being provided by the application of internal fluid pressure within the tubular member.

2. A tubular fabrication as claimed in Claim 1 comprising a camshaft wherein one or more of said elements comprises a cam profile ring.

3. A tubular fabrication as claimed in either one or Claims 1 or 2 wherein one or more of said elements comprises bearings or gears.

4. A tubular fabrication as claimed in any one of the preceding claims wherein the or each said element is formed from a ceramic or sintered material.

5. A tubular fabrication as claimed in Claim 2 wherein the tubular member is formed of a low carbon steel and the cam profile rings are formed of a high strength hardenable ductible steel.

6. A method of producing a tubular fabrication comprising locating one or more elements around a central tubular member and radially deforming said member with respect to the or each element by the application of internal fluid pressure within the tubular member to secure the or each element against movement relative to the tubular member.

7. A method according to Claim 6 for the production of a camshaft wherein one or more of said elements comprises a cam ring.

8. A method according to Claim 7 wherein each cam ring is shaped substantially to its final cam profile before it is secured to the tubular member.

9. A method according to Claim 7 wherein each cam ring is shaped partially to its final cam profile before it is located around the tubular member, each said cam ring then being shaped to its final cam profile during the application of internal fluid pressure to the tubular member.

10. A method according to Claim 7 wherein each cam ring is initially of circular form before it is located around the tubular member, each said cam ring then being shaped to its final cam profile during the application of internal fluid pressure to the tubular member.

11. A method according to any one of Claims 6 to 10 wherein the fluid pressure is applied to the interior of the tubular member via a hydraulic medium.

12. A camshaft constructed and arranged substantially as hereinbefore described with reference to Figures 3 and 4 of the accompanying drawings.

13. A method of producing a camshaft substantially as hereinbefore described with reference to the accompanying drawings.

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